Superadiabatic quantum heat engine with a multiferroic working medium

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A quantum thermodynamic cycle with a chiral multiferroic working substance such as LiCu2O2 is presented. Shortcuts to adiabaticity are employed to achieve an efficient, finite-time quantum thermodynamic cycle, which is found to depend on the spin ordering. The emergent electric polarization associated with the chiral spin order, i.e., the magnetoelectric coupling, renders possible steering of the spin order by an external electric field and hence renders possible an electric-field control of the cycle. Due to the intrinsic coupling between the spin and the electric polarization, the cycle performs an electromagnetic work. We determine this work's mean-square fluctuations, the irreversible work, and the output power of the cycle. We observe that the work mean-square fluctuations are increased with the duration of the adiabatic strokes, while the irreversible work and the output power of the cycle show a nonmonotonic behavior. In particular, the irreversible work vanishes at the end of the quantum adiabatic strokes. This fact confirms that the cycle is reversible. Our theoretical findings evidence theexistence of a system inherent maximal output power. By implementing a Lindblad master equation we quantify the role of thermal relaxations on the cycle efficiency.

References:

L. Chotorlishvili, M. Azimi, S. Stagraczy´nski, Z. Toklikishvili, M. Sch¨uler, and J. Berakdar, " Superadiabatic quantum heat engine with a multiferroic working medium", PHYSICAL REVIEW E **94**, 032116(12) (2016),